

USE OF THE 4D-GLOBAL REFERENCE ATMOSPHERE MODEL (GRAM) FOR SPACE  
SHUTTLE DESCENT DESIGN

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This discussion centered on the method of using the GRAM mean and dispersed atmospheres to study skipout/overshoot requirements, to characterize mean and worst case vehicle temperatures, study control requirements, and verify design. Landing sites in these analyses range from 65°N to 30°S, while orbit inclinations vary from 20° to 98°.

McCarty's primary concern was that they cannot use as small vertical steps in the re-entry calculation as desired because the model predicts anomalously large density shear rates for very small vertical step sizes. This is an artifact of the model which needs study.

The winds predicted by the model are not satisfactory. This is probably because they are geostrophic winds and because the model has an error in the computation of winds in the equatorial regions.[Smith]

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USE OF  
THE 4D-GLOBAL REFERENCE ATMOSPHERE MODEL (GRAM)  
FOR SPACE SHUTTLE DESCENT DESIGN

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- DESCENT USES GRAM MEAN-MONTHLY AND DISPERSED ATMOSPHERES TO:
  - DETERMINE SKIPOUT/OVERSHOOT TARGETING REQUIREMENTS
  - CHARACTERIZE MEAN AND WORST CASE VEHICLE TEMPERATURES
  - ANALYZE ALPHA MODULATION/TRAJECTORY CONTROL REQUIREMENTS
  - VERIFY DESCENT DESIGN
  - DEFINE PRODUCTS (FLIGHT DATA FILE, MCC AND ONBOARD DISPLAYS, ETC.)
- MEAN-MONTHLY AND DISPERSED ATMOSPHERE MODEL PRODUCTS CURRENTLY SUPPORT MANY SIMULATORS
  - DDS - DESIGN
  - SVDS/MONTE CARLO - PRODUCTS AND VERIFICATION
  - MCC - DEORBIT TARGETING AND REAL TIME MONITORING
  - SMS - CREW TRAINING
  - SES, SPF, SAIL SIMULATORS
  - NAV GROUP - DRAG ALTITUDE UPDATE I-LOADS

# GLOBAL USE OF GRAM

- LANDING SITES, 65° N. TO 30° S. LATITUDE
- ALTITUDE, 120 TO 0 KM.
- INCLINATION 28° - 98°

## CONCERNS

- SMALLER ALTITUDE SPACING SHOWS INCREASED DENSITY SHEAR RATES

## WINDS

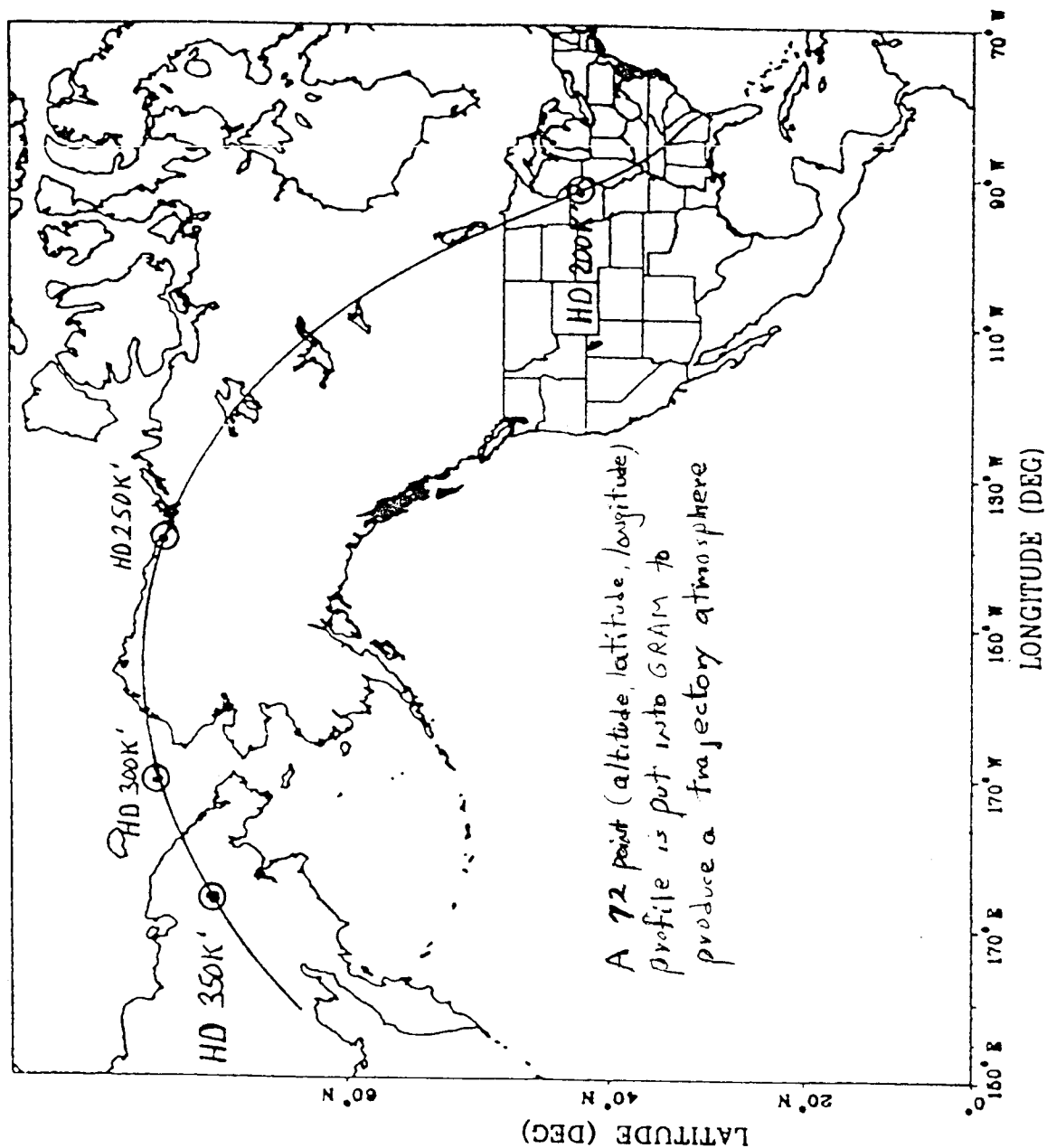
- DISPERSED WINDS, ALTITUDE 90 - 60 KM
- MEAN WINDS, ALTITUDE APPROX. 20 KM
  - LARGE WIND SPIKES, 1000 FT/SEC
  - LOCATED IN THE SOUTHERN HEMISPHERE
- METHOD USED TO CALCULATE THE PERTURBATED ATMOSPHERE AND WIND STANDARD DEVIATIONS

- BEING REVISED BY JUSTUS

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# ALTITUDE PROFILE

